VOLUME 116 NUMBER 4 APRIL 1960

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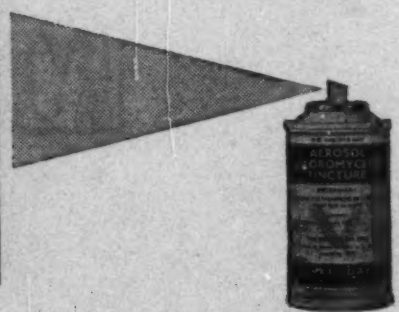

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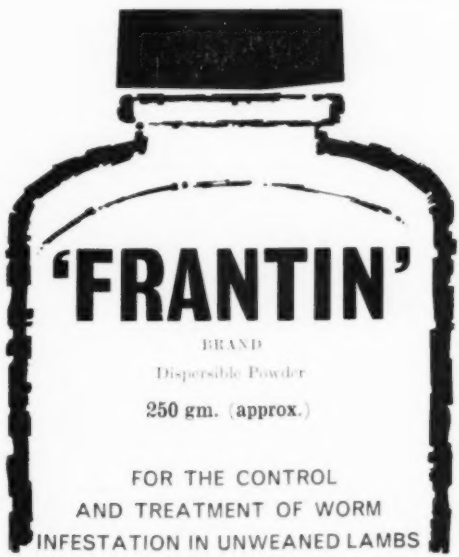

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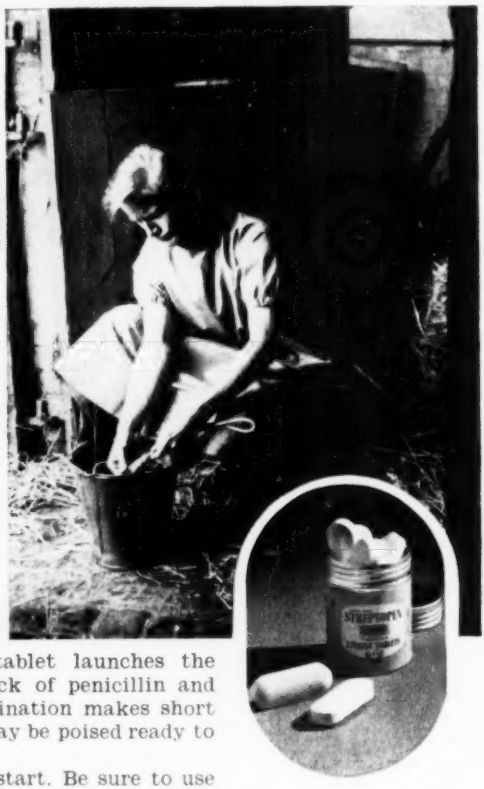

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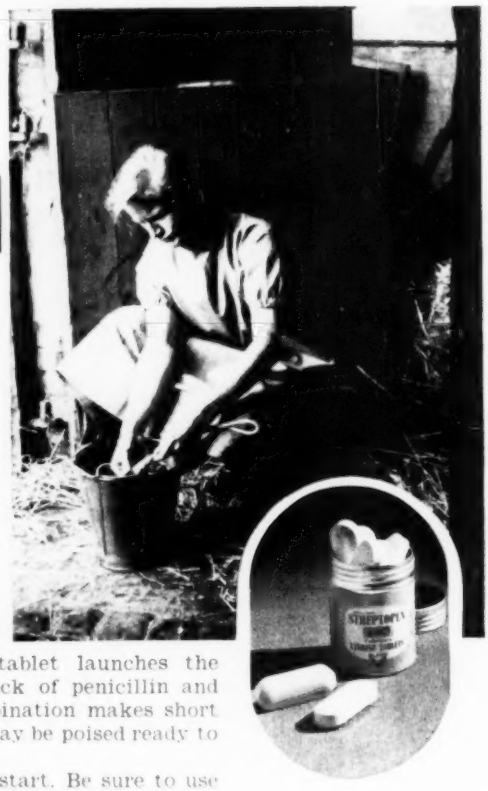

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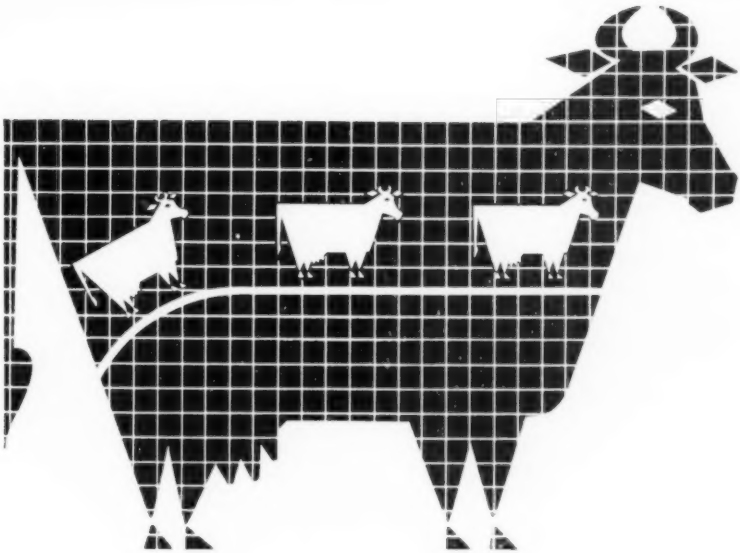

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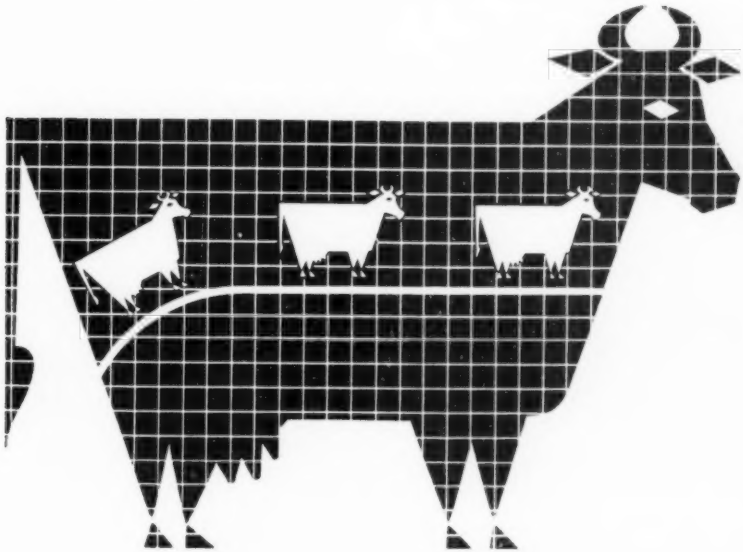

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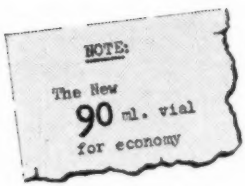

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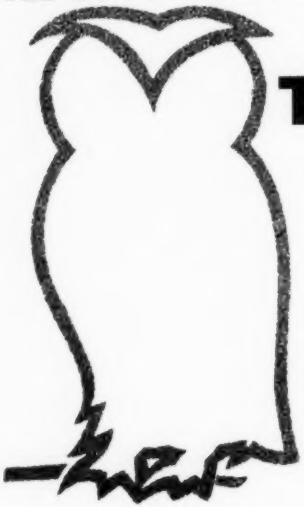

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Dr. Romanoff is a fellow of the New York Academy of Sciences and the American Association for the Advancement of Science. He is also a member of the American Chemical Society, the American Physiological Society, the Society of Experimental Biology and Medicine, the American Society of Zoologists, and the Society of the Sigma Xi. In 1950 he received a Borden Award and gold medal for his investigations in avian embryology, which have been conducted continuously at Cornell since 1926.

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SIR THOMAS DALLING, *M.A., D.Sc., F.R.C.V.S., F.R.S.E.*

Vol. 116 **April, 1960** **No. 4**

EDITORIAL

PROFESSIONAL STATUS

Until quite recent times a professional man was of some consequence and he was held in very high regard by his neighbours and also by the public at large. The medical and veterinary professions merited this approbation to a high degree. There were many reasons for this respect. It was recognised that a candidate for one of the professions had to produce evidence of a relatively high standard of general and cultural education before he could commence his period of training. As a rule such a demand was not made of those who embarked upon a career in trade and in the commercial world. It was known also that the curriculum which led to acceptance into a profession was long and arduous and that at specified intervals during its course the candidate had to submit to very stringent tests of competence. It was known also that the period of training might extend over many years, was without immediate financial reward, and only those who were strong in their desire and were supported and encouraged by their parents or guardians could dare to attempt the course. Many of the candidates did not come from families well endowed with this world's goods and in consequence they had to endure a considerable amount of physical and social hardship and forego many pleasures at a time of life when they are most appropriate and can be enjoyed with full zest.

These things were known to the general public and were acknowledged with due regard and respect. Few men entered upon such a trial unless they were imbued with a deep urge to follow the particular career of their choice. It was this attribute which gave them strength and helped to earn the status and respect which was accorded to a professional man. It was a form of dedication and in some way this was reflected in their physical appearance and conduct. Professional men had a bearing and manner different to that of the common man. It varied a little according to their metier so that it was relatively easy even during their undergraduate days to recognise medical, veterinary, engineering and other students. After graduation, when they could begin to practise their calling, the stamp of their vocation often became indelible.

Modern undergraduates are all very much of the same mould and by visual means alone it is difficult to differentiate them according to their particular discipline. As regards the qualified professional man one can scarcely distinguish him on sight from a tradesman or city clerk. How or why has this evolution occurred? It may be that under present comfortable conditions provided by a beneficent state and other bodies, when student life is shorn of many of its hardships and the candidates come from a much wider field, the stimulus of a deep vocational urge and a sense of dedication are not important primary assets.

Family associations and environment do not seem to play much part in the selection of a career. In the veterinary schools an insignificant number of the students are derived from veterinary families. It may be that the whole concept of veterinary and medical work has changed. In the past medical and veterinary work was orientated around an individual patient, in present times emphasis is placed on preventive measures applied to the mass. The diagnosis and treatment of disease in the individual presented, in every case, a new and personal challenge to the professional attendant's judgement, ability and skill. Modern preventive measures are often as rigid in form as a blue print. When the disease has been identified subsequent action is according to set rules. The implementation of these rules follows a regular or routine plan and these actions or measures do not call for the exercise of much deep thought and cogitation. The man who recognised the disease in the first instance and set the necessary wheels in action often plays no further part in the incident. The men who implement the routine measures can be likened to the workers on the assembly line in a mass production automobile factory: they cannot diverge from the blue print and their task can become monotonous and breed boredom and ineptitude.

Men are judged by their fellows according to their character, ability and initiative. Routine work does not tend to cultivate these attributes. A profession gains its place in the esteem of the public according to the respect which its individual members command. This may be one of the reasons why modern professional men do not rank so high in the public estimation as their independent forbears did; it may be the reason why many who now seek to enter the learned professions lack a true vocational urge and the sense of dedication and would be perfectly happy in any other job.

A man who just works for a living cannot have much love for his job or hope to preserve and enhance the quality and dignity of his profession.

VETERINARY EDUCATION

By SIR THOMAS DALLING, M.A., D.Sc., F.R.C.V.S., F.R.S.E.

The importance and value of the work carried out by the veterinary profession is recognised and appreciated throughout the world. This has been made manifest to me during visits to many countries and by discussions with responsible authorities. The profession provides services which are essential to the progress and well-being of individuals and nations throughout the world. The economic position of countries and the health and welfare of their peoples depends, in no small degree, upon the efficiency of the veterinary services.

The vastly different conditions of life, for man and livestock in different regions and countries have to be appreciated and understood before we can make a reasonable assessment of the type of work which veterinary surgeons may be called upon to undertake. Science is progressing rapidly and the application, in the field, of new knowledge has repercussions on the day-to-day work of veterinary surgeons in all branches of the profession.

Those who have reached an age when they can look back for almost half a century and review the changes that have taken place in the veterinary field can appreciate and understand why and how these changes have occurred. They can see how new scientific discoveries have been applied in our work, how improvement in animal health has an important bearing on human health, and how it is necessary to deal with animals in the mass, as well as giving attention to individuals.

Progress and changes are not confined to the veterinary profession: they affect equally work of any kind. These relatively rapid changes cause one to consider how the educational system should be planned and especially how the veterinary surgeons of the future should be trained in order that current and future requirements may be met. This is an appropriate time to review the veterinary requirements for different regions of the world, how veterinary services can operate best in the various regions and the education and training of veterinary surgeons and their auxiliaries so that they may render maximum service.

The subject has to be approached without preconceived ideas and we must not be tempted to become judges, or strong supporters, of any schemes before acquiring the necessary knowledge and experience of the conditions and requirements. We must not be tempted to assume that the methods which apply to an area with which we are familiar will be successful in equal manner in other parts of the world. We must consider the needs of countries, regions, and peoples in different parts of the world before we give general opinions on the work and the education and training of veterinary surgeons and their auxiliaries.

Some countries have been always in the forefront with regard to veterinary education. Their influence in other parts of the world has been great, and in travelling throughout the different regions it is not difficult to observe the results. That influence has played an essential part in laying the foundations of sound veterinary services. Well-trained veterinary surgeons have gone abroad and established the efficient veterinary services in the lands of their adoption.

We cannot rest content; we must look into the future. In the well developed parts of the world where there are old-established veterinary services and veterinary schools, appropriate measures will, doubtless, be taken to amend

the teaching according to the requirements of the area, taking account of all advances in the application of new and better techniques. As regions become better developed, as their livestock and livestock industries increase, as their economic positions improve, as more attempts are made to increase exports and imports of livestock and livestock products, and as greater interest is taken in human health, veterinary services will play a role of increasing importance. The peoples of the regions will participate fully in the development of veterinary work in their countries. Their education and training to fit them to be of the best possible service becomes a matter of outstanding importance. The profession must be prepared to render appropriate advice and assistance.

The Food and Agriculture Organisation of the United Nations, there are 86 member countries, includes animal health in its programme. The Organisation recognises the need for efficient veterinary services, especially in those countries in which the livestock industry is being developed. It is giving all possible assistance, within its financial limits, for their improvement. The necessity for a sound technical and scientific educational system as a foundation on which to build is appreciated fully.

Contacts with individual countries and discussions at regional meetings have caused F.A.O. to convene an International Meeting on Veterinary Education in which veterinarians from many different parts of the world will participate. By agreement of the Government of the United Kingdom, this meeting is being held in Church House, Westminster, London, S.W.1, on 25th-29th April, 1960. In the comparatively short time of the meeting it will not be possible to give much attention to detail: the discussions will be on general lines. No doubt some recommendations will come from the meeting. It is hoped that one will be: "That F.A.O. should give consideration to the establishment of an International Panel, whose terms of reference will include 'to consider and report on veterinary education in detail, special note being taken of any recommendations made at this meeting'."

This is the first occasion on which an international meeting has been convened for the express purpose of considering veterinary education. It will be the beginning of a real attempt to give the subject the attention it deserves. Should an International Panel be recommended and ultimately established, its work should culminate in the production of a review of the veterinary needs of countries and regions and the systems of education to meet the requirements. It is hoped that the findings and suggestions of the Panel may be discussed and amended, where necessary, at a Second International Meeting on Veterinary Education to be held in a few years time and following that meeting a full publication will be made for the guidance of those responsible for veterinary education throughout the world.

The draft agenda of the first Meeting includes: Education and specialised training to meet regional requirements of veterinary services; Education and specialised training in different subjects (Undergraduate and post-graduate); Education and training of lay staff for veterinary duties; and the Establishment of an International Panel to consider and report on veterinary education in detail, special note being taken of any recommendations made at this meeting.

ON STRUCTURE AND FORM IN DOMESTICATED ANIMALS

By T. D. GLOVER, M.A., Ph.D., B.Sc., M.R.C.V.S.
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"... out of which Earth and Heaven were born.
And from their mingling thence are poured abroad
The multitudinous birth of mortal things,
Knit in all forms and wonderful to see."*

In veterinary anatomy the structure of domesticated animals is studied and the adjective "domesticated" has come to have a distinct connotation in conveying the impression of a limited number of species. Attentions are thus frequently confined by this limitation to animals usually met by practising veterinary surgeons. The horse, ox, sheep, goat, pig, dog, cat and fowl fall into this category. But is the student of veterinary anatomy completely justified in this interpretation of "domesticated animals"? If he accepts the term conventionally, he will look with a somewhat jaundiced eye at the popularity of chinchillas in this country. He might be even more disconsolate when he reads of snakes being the latest fashion in pets, nervous at the prospect of being called out to a circus or a zoo and conscious of his potential gaucheness on coming face to face with a rodent or lagomorph in an animal clinic. The fact is that extraordinary animals are from time to time domesticated and it would seem prudent to consider "domesticated" animals in the widest possible sense. Certainly in anatomy it is impossible to comprehend the significance of structure in domesticated animals without consideration of mammals as a whole and their relation to lowlier forms of life. To achieve this broader understanding, some appreciation of general vertebrate morhpology must be sought. In this the student of anatomy need go no further than two well-known textbooks (Romer, A. S., 1949, and Young, J. Z., 1955) to be made aware of the intense fascination of comparative anatomy. Veterinary anatomists are specialists and it is their lot to explain and demonstrate as far as they can how, as regards structure, the conventionally accepted "domesticated" animals fit into the general biological picture and are related to their fellow creatures in the animal kingdom.

Despite the absorbing interest which structure offers as a subject for study, it must be conceded that it *tempts* more speculation than would be permitted by a sound experimentalist. This would seem to be due to the admittedly seductive quality of certain Lamarckian ideas detracting from an unqualified acceptance of Darwinian principles. The conflict, when it exists, would seem to be between scientific discipline and the more romantic side of an anatomist's nature. That the former is more likely to succeed ultimately, is not to claim that divided loyalties never exist. The science of genetics has done much to clarify the position, but a gnawing enigma remains. If *mutations* and *natural selection* largely account for

*Quotation taken from *The Human Situation* by W. MacNeile Dixon (Gifford Lectures) 1948. London. Edward Arnold.

variations in anatomical structure, what stimulated the mutations to occur in the first place? To answer the question on the basis of it all being "pure chance" may seem rather unsatisfying, but at least it has opened up a whole field of research. In more than this slight hesitation regarding the origin of anatomical types, it is not justifiable to point an accusing finger at the anatomist for speculative thinking, and in all charity the experimentalist might grant him little excursions into teleology if only to occupy his rare moments of leisure!

Nevertheless an attempt has been made in the present paper to indicate that anatomy is primarily an experimental subject, and emphasis has been laid on general principles rather than on the details of structure and form. For this reason, only a few works appear in the bibliography out of a most extensive relevant literature. Illustrative examples of anatomical structures have been deliberately omitted also since it was not thought that clarity of the arguments demanded their inclusion.

The Meaning of Anatomy

If veterinary anatomy is a subject that deals with the structure of domesticated animals, it might be claimed that most aspects of gross structure have already been observed and described, and that the subject thereby only consists of a dreary catalogue of facts. Little could be further from the truth than this, but in fairness an alternative must be put. Anatomy, by definition, refers to 'cutting up' (Lat. *anatomia, c.p.* Gk. ἀνατομία, — connected with 'dissection.' Also Gk. τομή, meaning 'place from which something has been cut," τόμος a cut slice,' and τομός adj. 'cutting, sharp')* and has come to mean the art of dissection. Thus anatomy involves cutting the body to pieces; it indicates a method of analysing the parts of the body in order to find out what constitutes structure and form, or indeed to discover why an individual has structure and form at all.

Early anatomists, with little equipment at their disposal, simply carved up cadavers and observed the structures contained therein. Nowadays the process of carving up or dissection has become more refined. Anatomical scientists are no longer satisfied with the existence, position, size and shape of an organ in the body, they are anxious to display the pattern of its construction and to disclose the materials of which is composed ; they are also curious to know something of the function that it serves. This deeper enquiry into structures applies not only to the biological sciences but also to the mechanical sciences and other spheres of study. If the veterinary anatomist were to restrict himself therefore to the mere observation of organs in the body and their arrangement, he would place himself in an analogous position to an architect who only draws plans, a chemist who simply describes the colour and gross appearance of an element, or an engineer who just outlines the parts of a machine. Systematic description of an animal is a start, but as the history of anatomy has shown, it is quite incomplete as a means of "understanding" its total structure.

* From *The Universal Dictionary of the English Language*. Ed. H. C. Wyld (1954). London: Routledge and Kegan Paul Ltd.

The Shorter Oxford Dictionary (1944). Ed. C. T. Onions. Oxford: Clarendon Press. Gives ". . . the science of the structure of organized bodies" and under "Anatomize" mentions ". . . lay open minutely —to analyze."

Although anatomy is associated with cutting up, it is to be realized that if the cut is made deep enough and fine enough, the tissues of the body will be revealed, the cells of which they are composed and even the intracellular structures. The vital contribution of these tissues to body structure has been classically presented (Clark, Le Gros, 1958). It is perhaps from this angle more than any other that one is reminded acutely of the relationship of structure to function. Indeed the key to this relationship lies in the cell theory put forward by Schleiden and Schwann in 1839. In a standard text-book of human anatomy (Boyd, J. D., Clark, Le Gros, Hamilton, W. J., Yoffey, J. M., Zuckerman, Sir Solly, and Appleton, A. B., 1956) the authors write in the Preface " The observation of changing structure during life becomes inseparable from the study of function, and indeed unintelligible without it." Herein lies one of the most significant realizations in the study of structure. The teacher of anatomy hesitates to make the banal statement that most organs of the body serve a function ; this is a pity, for although it is a truism, it provides a starting point for one of the most important and fruitful aspects of anatomical study. The inclusion of function as a topic in anatomy involves a wide range of biological considerations, but completely invalidates any argument that anatomical knowledge is complete.

A scholar may be well informed on the macroscopic structure of an animal, but with this equipment only, he has not advanced beyond the stage of the earliest anatomists. This is no derogation of anatomists in previous ages, on the contrary, when judged against the background of their times they must be regarded as fine scholars and distinguished scientists. Aristotle was a fine scholar (certainly he made some interesting observations about animal structure*), Copernicus a distinguished scientist, and Galen a keen observer, but in the light of modern philosophy and science much of what they said would seem, if not incorrect, at least inadequate to satisfy contemporary minds. In short, it is obvious that knowledge has expanded and concepts have changed as man has matured in his sciences. Much more is known now about the details of structure in living creatures so that simple information on macroscopic form in itself is no longer enough. In their individual scientific disciplines men can no longer be satisfied to fly to the ends of the earth, they must be prepared to send satellites to the moon.

The advance in anatomical thought entails some intriguing but difficult problems, for biologists have made the anatomist think again about his basic concept of structure. The appreciation that animals are not made up of stable elements but that there is constant interchange of materials between any structure and its environment has been alarming. This is because it strongly suggests the necessity of a complete re-appraisal of earlier beliefs about structure and form. It has been somewhat startling to realise that the animal body cannot be considered as stable any more than the atmosphere can be regarded as static. From this it is apparent that any approach to the anatomy of animals should take into account, not only the function of different organs, but, as far as possible, the factors which govern structure as a whole and have influenced it in the past.

* Russell, E. S. (1916): see reference to the famous " Historia Animalium."

Structure and the Environment

The fact that an animal can be observed indicates its particular type of structure. This sounds so obvious that it can easily be overlooked. That an animal has shape shows that it is distinct from its environment. A snowflake is a definite entity in the sky but when it descends upon a rivulet it loses its identity in a new watery environment. A bubble has shape, and moreover its outline can be altered by applying different pressures at certain points on its surface, but it merges with the atmosphere and disappears when it bursts. Such is the case with animals. When they are alive they have shape and form but when they die they lose eventually the features which characterized them. Painters may argue academically about shape and form, psychologists theorize about appreciation of structure, but all must agree that the possession of structure and form by an object or a living creature denotes a distinctness from the environment. The maintenance of this basic separation is a part of survival. Thus an animal needs to surmount any environmental change that might be deleterious to its general structure. Since most animals are subjected to various circumstances during their life, it would seem necessary for them to be endeavouring constantly to maintain a stability despite adversities wrought by changing environmental conditions.

The effort on the part of the animal body to reconcile itself with the environment is usually referred to as 'adaptation,' and it involves methods adopted by an animal for the maintenance of as steady a state as possible in all conditions. The resulting stability is known as 'homeostasis' and its achievement necessitates perpetual interchanges between the individual and its environment (see Young, J. Z., 1957). These interchanges not only concern the outward form but occur within the body also because individual cells have their own immediate environment. Furthermore, cells themselves provide an environment for intracellular structures such as the various organoids and nuclear components. The relationship of structure and environment may on these grounds be pursued to infinitesimal extremes and the only restriction is that imposed by current anatomical and physiological knowledge.

Undoubtedly methods of adaptation will vary according to particular environmental factors, so that adaptive changes in marine organisms could be expected to differ from those of birds, and these to be distinct from those of purely terrestrial beasts. Similarly, in the evolutionary history of any one species, adaptive mechanisms are likely to have varied at different stages; adaptation of a species in the Oligocene age for example should be different from that in the Miocene, Pliocene or more recent ages. Evidence for this is to be found in the evolution of ruminants and horses. Fundamentally adaptation is concerned with the maintenance of stability during the lifetime of an individual only, and any particular adaptive process does not necessarily characterize later generations. Mass movements and migrations of animals during evolution, however, would enable animals of slightly different types to find themselves in the same environment, to mate and reproduce their kind. On these grounds the interrelationship

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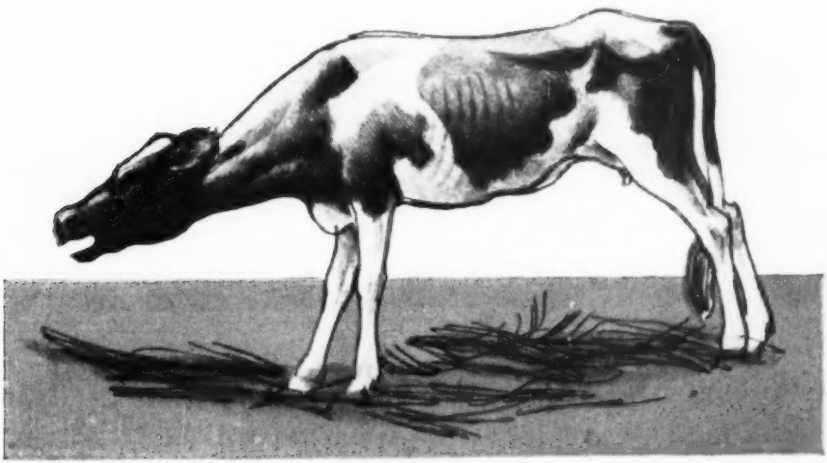

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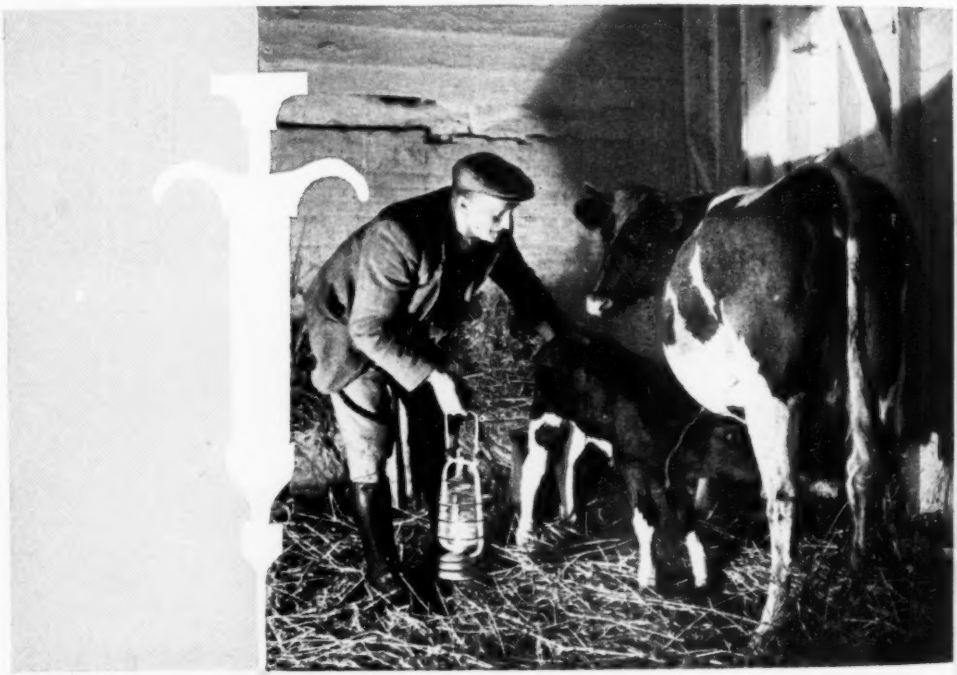

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of hereditary principles and environmental influences is essential to an understanding of how certain anatomical characteristics became acquired by any specific animal type.

If a hypothetical gene can be regarded as representing a potential adaptive mechanism, some indication of the possible evolution of adaptation may be obtained from simple Mendelian principles, bearing in mind that the potentiality could thereby be of dominant or recessive character. If an animal which was homozygous for a genetic factor A (representing a dominant potentiality for adaptation to environmental conditions *a*) allied itself with another homozygote possessing the gene B (representing a recessive potentiality for adaptation to environmental conditions *b*), then all the offspring first produced from the alliance could be expected to adapt easily to conditions *a*. If, on the other hand the environment was of type *b*, this first generation's members might succumb before they had grown old enough to reproduce. Assuming, however, that survival was achieved, these individuals (type AB) could mate with more of their own genotype, or alternatively with AA or BB which might have been produced in the same district or elsewhere. In the first filial generation resulting from these alliances the overall chances of survival in conditions "*a*" should be 75% (viz. 75%, 100% and 50% respectively) whereas in conditions "*b*" the chances would be only 25% (viz. 25%, Nil and 50%) since homozygous BB would be desirable for survival. This is assuming that the chances of each type of union were equal, and obviously the situation has been over-simplified. Nevertheless, if the principle can be accepted, and the infinite combinations of alleles concerned with potentiality for adaptation are considered, then the survival of particular types "by chance" is hardly surprising. At the same time these types may possess certain anatomical features unrelated to adaptation, and these might still be perpetuated in future generations. On the other hand, if mutations (which may be deleterious or even lethal in many cases) happen to produce change in structure or function which is suited to a given environment in which an animal finds itself, survival to reproductive maturity will be facilitated and an opportunity provided for an inherent adaptive procedure to develop within a species.

Even the simplest terms of reference to the history of the animal body therefore make it clear that the component structures of a living organism are in no way static, but represent a story of perpetual movement and change.

As for domesticated animals their association with man has been in the nature of a symbiosis and it is apparent that this has had a profound and special influence upon their structure and function.

Some Effects of Domestication

Although some direction in evolutionary change is perceptible, the process is revealed as haphazard when compared with more recent phases of domestication. The utilization by man of various animals has naturally produced alterations in their environment, and when the sociological aspects of different human races is taken into account, the effects of domestication appear as a complex factor in the ecology of animals (see Wright, N. C., 1954). Perhaps the most significant effect of

domestication has been that the responsibility for self-preservation no longer rests entirely with the individual. However, to be housed in a stable and hand-fed on hay and cereals must undoubtedly have constituted some change in environmental conditions, for horses and cattle for instance, and it would thus be expected that new adaptive mechanisms might be called upon or old ones rejected in order to deal with the situation.

Domesticated mammals, being of a relatively advanced type, might have been able to adapt themselves by physiological means without necessarily undergoing gross anatomical change, so that in terms of structure it would not be surprising if early man's domesticated animals were fundamentally similar to existing types. But more recently, as new channels of knowledge have become available, man's power to influence the characteristics of his animals has increased. The science of genetics must be acknowledged as playing a major rôle in the creation of this authority. By experiment, man has altered the anatomical structure of many types of animals. Examples can be seen in the dairy cow, the beef cow, the racehorse, the polo pony, the hunter, the greyhound and the gun-dog. He has bred some sheep for their wool and others for meat, some pigs for bacon and some for pork. Birds whose flight is impaired but whose capacity for egg-laying is great, populate almost every farm. Thus in domestication man has not only seized upon anatomical structure in animals and used it appropriately for his needs, but he has altered it and augmented its value for his own purpose. At the present time man's knowledge of animal breeding and production is so extensive as to constitute a science in itself (see Hagedoorn, A. L., 1950).

The effects of domestication make up the most recent chapter in the evolutionary history of structure and form ; they illustrate that the efficiency with which anatomical structures perform various functions is a matter of considerable significance.

Dynamic Aspects of Anatomy

In addition to contemplations of the effects of evolution on animal structure, anatomical changes during the lifetime of an individual are also the province of the anatomist. Metamorphosis from syngamy to adult life is so complex that at first sight it might appear as a subject of study completely separate from anatomy. The manner in which anatomical features develop, however, is clearly relevant to a full appreciation of structure and form, and studies in embryology thereby provide a most useful basis for a comprehension of the anatomy of adult animals. Haeckel's " Biogenetic Law " (stating that ontogeny recapitulates phylogeny) has been shown to be a misguided interpretation of development, but Von Baer's earlier proposition was that at certain stages in the ontogeny of man and the higher animals, characteristics of the embryo bear a resemblance to those of embryos in lower forms of vertebrates. This is of great interest in that it reveals a close relationship between pre-natal development and the structure of animals in general.

As in evolutionary history, the sometimes antagonistic action and sometimes synergistic effect of hereditary and environmental factors play a vital part in the life history of animals. The mode of reproduction itself, is related to this life history.

and the uterine environment for the developing embryo features strongly in the picture together with the psychological control of this environment. Other aspects of the embryology of domesticated animals include the characteristics of placentation in eutherian mammals generally and also the process of parturition. These and many other related problems warrant serious study by the anatomist.

What makes an animal develop and how are changes in structure achieved ? The question is not solved completely and a lot of research is being carried out in the investigation of these problems. Many experimental studies have already been made into the " why and wherefore " of embryonic development and the value of interdisciplinary techniques has been demonstrated admirably by the invaluable contributions of chemical embryology (Needham, J., 1931 ; Brachet, J., 1947). Experiments have also afforded a better understanding of possible causes of abnormal development, and increased knowledge in the sphere of teratology should be of distinct service to the veterinary clinician.

Anatomical changes continue after an animal is born, and all the many facets of growth and senescence are worthy of consideration in veterinary anatomy, for these too are indispensable to an understanding of adult form (Clark, Le Gros, and Medawer, P. B., 1945). Thus in the life history of an animal as well as in its evolutionary history there is plenty of evidence that anatomical structure is always changing. Anatomical science must therefore be concerned essentially with dynamic processes.

Conclusions

There would appear to be two main routes by which structure in domesticated animals can be investigated, the historical approach and the experimental method. Whichever of these means is chosen, the other cannot be totally disregarded by an anatomist.

Vertebrate palæontology (Romer, A. S., 1947) has given in large measure a description of the historical scene as it is known from the evolutionary standpoint. There are still several gaps in the material, although doubtless these may be filled as more fossil remains are unearthed and other evidence is produced. Meanwhile it can be dangerous to speculate as to what happened in the past, but there is adequate evidence for assertions to be made about many aspects of evolution. It is probable that these can still be of considerable help to embryologists when their findings fail to provide a coherent picture of development.

Despite this appreciation of the historical approach, an effort has been made in this paper to illustrate that, in the light of present knowledge, the most penetrating studies of structure in animals are likely to be made by means of experiment. This has been based mainly upon the significance of the interplay between genetic and environmental factors. In domesticated animals, the maintenance of homeostasis evokes a host of processes that clearly lend themselves to experimentation.

Finally it is suggested that the extensive interest and adventure in the study of veterinary anatomy may easily be obscured from the undergraduate student unless it is deliberately pointed out to him. With the finesse of observation

demanded of him in the dissection room, and the burden of remembering details of gross structure, he can forget the many available scientific aids to his memory, and worst of all he might fail to grasp the meaning of anatomy. There are good students and bad ones, but it is reasonable that the prize—which in this case is to appreciate a value if not an excitement in the study of structure and form—should be open for all to compete rather than being available only to the chosen few.

> " . . . for without some knowledge of the *why* things are so, the facts of anatomy stand as so many isolated items, while with such knowledge they become bound together to a continuous whole and their study assumes the dignity of science." McMurrich (1923).

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PATHOLOGY OF THE CETACEA
A VETERINARY STUDY ON WHALES—Part I

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The modern whaling industry makes a notable contribution to the world's food stocks. Whales are hunted and killed by pelagic expeditions in the Antarctic, and by catcher-boats based on shore stations in many parts of the world.

The acquisition of the valuable baleen whale oil is the basis of the industry. The by-products which result from the processing of the whale carcass are incidental to the main industry, but in a world starved of protein, their importance is manifest.

The field offered for clinical observation in the whaling industry is largely unexplored. The author was a member, as Whale Fishery Inspector and Veterinary Officer, of the "Southern Venturer" Antarctic pelagic whaling expedition in 1948/49 and as Veterinary Officer, of the "Balaena" expedition in 1951/52. On each occasion the incidence of disease was investigated and all meat intended for human consumption was inspected. Special attention was paid to the possibility of the occurrence of any of the zoonoses. An attempt has been made to describe lesions which were observed, and to present a survey of the present knowledge of the pathology and parasitology of whales hunted in the Antarctic.

Parasitic Conditions

Whales are richly infested by a variety of parasites, both internal and external. This subject has been dealt with by Baylis (1916, 1920, 1922, 1923, 1926, 1929, 1932), Hamilton (1916), Chapin (1921), Hart (1935), Omura (1950), Nybelin (1922, 1928) and others. A recent communication is that of Rees (1953), who examined, identified, and described in detail the specimens collected by the author during the 1951/52 expedition.

1. *Ectoparasites*

Whales are commonly hosts to a variety of barnacles. These are more frequently found on the slower-moving species (Harrison Matthews, 1952). In Antarctic waters, Humpback whales are often heavily infested. Specimens are occasionally found on Fin whales, rarely on Blue whales. In warmer waters infestation is heavier. The characteristic cicatrix-mottling has been attributed to this type of infestation and also to parasitic lampreys. (Pike, 1951).

Specimens collected from Humpback whales in the Ross Sea area have been identified as *Coronula diadema* L., and *Conchoderma aurita* L. The predilection sites are the "rifler" or deep skin corrugations of the throat region, the anterior part of the lower jaw and the leading edge of the flippers. Occasionally the degree of infestation is remarkably heavy. Humpback whales are noted for their playfulness, and they will often rub themselves against the hull of a ship. This may be done in an attempt to rid themselves of a source of irritation.

Coronula reginae Darwin has been recovered by the writer from the anterior region of the lower jaw of a Blue whale.

Lice are found on all species of whales, most commonly in the vicinity of the genitalia. They occur also on the head, on the flippers, and in the "rifler" almost anywhere on the ventral surface of the body. Sars (1890-95) observed that *Paracyamis boopis* (Lutken) was generally associated with the barnacle *Coronula diadema* and this was noted also with regard to the specimens, collected by the author, from the flipper of a Humpback whale.

Conchoderma is found frequently on the teeth of Sperm whales, in particular those which have suffered injury leading to deformities in the lower jaw. Some injuries are very extensive and it is incredible that the whales have been capable of catching sufficient food to remain alive (Loth, 1931 ; Murie, 1865). Instances have been reported of a fractured lower jaw having set at an angle of 45° to the natural position, and in such a manner that closure of the mouth was impossible. In such whales the reduced speed would facilitate lodgment of the parasites, which are most commonly encountered in tropical and sub-tropical waters and only occasionally observed in Antarctic regions.

In the photograph (Fig. 1), which was taken in the slipway of the floating factory, the whale is lying on its left side and the deformity of the lower jaw can be seen as a lateral curvature for a length of approximately 60 cm. At the anterior end of the lower jaw, and within the curvature a colony of barnacles, which cover the teeth in the vicinity, can be seen.

The skin colour of both Blue and Fin whales exhibits varying degrees of colour-shading in different sea areas. It appears to the author that the faculty of protective coloration is well exemplified by certain species of whales. The range of colour is increased by a diatomaceous deposit which is noted frequently, and particularly as the season advances (Hart, 1935 ; Mizue, 1950). This takes the form of a thin uniform film of a brown or greenish scum adhering to the skin surface, and extending over the back and belly regions. It is observed most commonly in Fin whales, but often patchy deposits are to be seen on Blue whales.

The fact that the deposit increases as the season advances would appear to give an indication of the length of time the individual whale has been in Antarctic regions, since the deposit is observed only seldom, and in small amount, in warmer waters (Karcher, 1940 ; Mizue, 1950 ; Nishiwaki and Hayashi, 1950 ; Omura, 1950). It is a factor which can be considered in assessing the migratory movements of whales (Hart, 1935).

The film of diatoms can be removed easily from the skin. The "golden" Fin whale is, by popular belief, in good condition and rich in fat ; the line of reasoning being that the heavy deposit indicates the length of time spent by the whale in the feeding grounds. The theory has been advanced that the colour is due to an accumulation of the living matter on which the krill, *Euphausia superba*, feeds. If a whale has acquired the coloration, it has been feeding in waters in which there existed a plentiful supply of krill-food, therefore there would

be a plentiful supply of krill, therefore the whale has been feeding well and the blubber layer will be thick. The experience of the writer does not support this theory and, in both the Weddell Sea and the Ross Sea, whales in thin condition and liberally coated with the film of diatoms have been observed. The skin deposit is an indication of the length of time spent by the host in Antarctic waters rather than a clue to its feeding habits or a sign of large stores of fat reserves. It is the author's contention that the colour of the skin of whales, however caused, does not appear to have any association either with the degree of fatness, or with the colour and condition of the musculature.

2. *Endoparasites*

Whales are peculiarly liable to infestation by a wide range of internal parasites. The observations made by the author in the Weddell Sea area during the 1948/49 season were augmented in the Ross Sea area in 1951/52, when a representative collection was formed. All the parasites were collected on the factory ship during the process of lemming, or dismembering the carcass, and four host species are represented.

The area in which the whale hosts were killed lies roughly between 67°51′ S. and 71°13′ S. in the Ross Sea. Laboratory facilities on floating factories are not extensive but the specimens were suitably preserved for later examination. Cestodes were fixed in five per cent. formaldehyde, nematodes and acanthocephala in hot seventy per cent. alcohol. Details of the sites in which parasites were found, and of any lesions produced by them, were recorded at the time of collection.

HOST LIST (Rees, 1953)

Balaenoptera musculus L. (Blue whale, Sulphur bottom, Sibbald's rorqual)
Synonyms: *B. sibbaldii, B. intermedia.*

Cestodes: Tetrabothrius affinis (Lonnberg, 1892)
Tetrabothrius sp.

Balaenoptera physalus L. (Fin whale, Finback, Finner, Common rorqual).

Cestodes: Tetrabothrius ruudi (Nybelin, 1928)
Nematodes: Crassicauda crassicauda (Creplin, 1892)
Acanthocephala: Bolbosoma hamiltoni (Baylis, 1929)

Megaptera nodosa Bonn. (Humpback whale).
Synonyms: *Megaptera longimana, M. boops.*

Acanthocephala: Bolbosoma porrigens (Rud, 1814)

Physeter catodon L. (Sperm whale, Cachalot)
Synonym: *P. macrocephalus*

Cestodes: *) *Priapocephalus grandis,* Nybelin, 1922.
*) *Tetrabothrius wilsoni* (Leiper and Atkinson, 1914)

Nematodes: Anisakis physeteris, Baylis, 1923

(*) New host records

CESTODA : Order *Cyclophyllidea :* Family *Tetrabothriidae*

(1) *Priapocephalus grandis,* Nybelin, 1922.

Host: Sperm whale. One specimen was found in the small intestine of a 16-metre male Sperm whale. This parasite has not previously been recorded in the Sperm whale which appears to be an unusual host as only one specimen was discovered. The length was 400 mm. In 1949, the author recovered a specimen from a Blue whale in the Weddell Sea area.

(2) *Tetrabothrius affinis* (Lonnberg, 1891), Lonnberg, 1892.

Host: Blue whale. Twenty specimens were reported from four Blue whales.

(*a*) A 25-metre female Blue whale. Two specimens were discovered free in the bile duct. It is presumed that they passed into the duct from the intestine during the process of lemming.

(*b*) A 22-metre female Blue whale. Eight specimens were recovered, three being preserved while still attached to the intestinal wall. Total infestation was estimated at approximately 100.

(*c*) A 25-metre male Blue whale. Six specimens were collected from the deck immediately after lemming. Precise location is unknown but infestation appeared to have been heavy.

(*d*) A 24-metre male Blue whale. Four specimens from the small intestine. Infestation moderate.

The length of the specimens of *Tetrabothrius affiinis* collected varied from 7 mm. to 127 mm. The local lesions, even where specimens were found still attached to the mucosa of the intestine, appeared to be negligible.

(3) *Tetrabothrius ruudi,* Nybelin, 1928.

Host: a 21-metre male Fin whale. Four specimens were removed from the small intestine. They were not difficult to detach. The degree of infestation was moderate and there were no signs of local irritation. The length varied from 61 mm. to 132 mm.

(4) *Tetrabothrius wilsoni* (Leiper and Atkinson, 1914), Baylis, 1926.

Host: a 17-metre male Sperm whale. Only one specimen was found, 300 mm. in length. This parasite has previously been reported only in the Sei whale.

It is of interest that both *Tetrabothrius wilsoni and Priapocephalus grandis,* previously recorded only in baleen whales, have now been observed in toothed whales. The food of the two types of whale is very different, and the Sperm whale is not so selective in his feeding habits as are the baleen whales, a fact which may be of value in identifying an intermediary host.

(5) *Tetrabothrius* sp.

This unidentified species occurs twice in the author's collection from the Ross Sea. It has not previously been described or recorded.

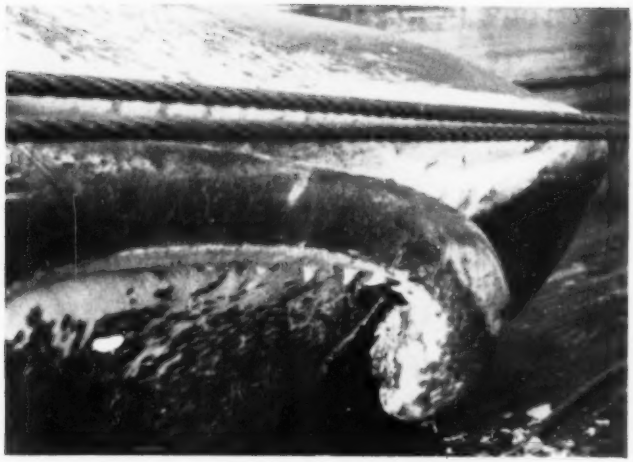

FIG. 1
Deformity of lower jaw of Sperm whale. Within the abnormal curvature is a colony of barnacles.
(Photo C. E. Ash)

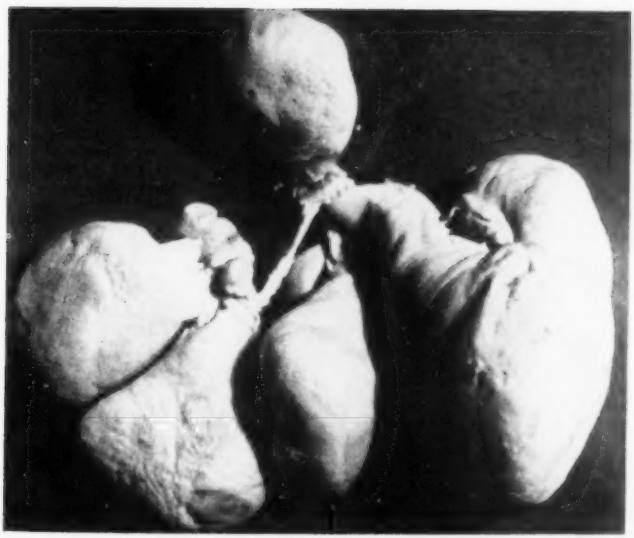

FIG. 2.
Multilocular cyst from a Blue whale, approximately $\frac{1}{4}$ size.
(Photo W. R. C.)

FIG. 3
Lipoma from the serous surface of the liver of a Blue whale, approximately $\frac{1}{4}$ size.
(Photo W. R. C.)

(Article by Cockrill, page 133)

PLATE II

FIG. 4

Abscess formation in the psoas muscle of a Blue whale. Numerous "husks" are present.
(Photo C. E. Ash)

FIG. 5

Lesions from the serous surface of the lung of a Blue whale, approximately ½ size.
(Photo W. R. C.)

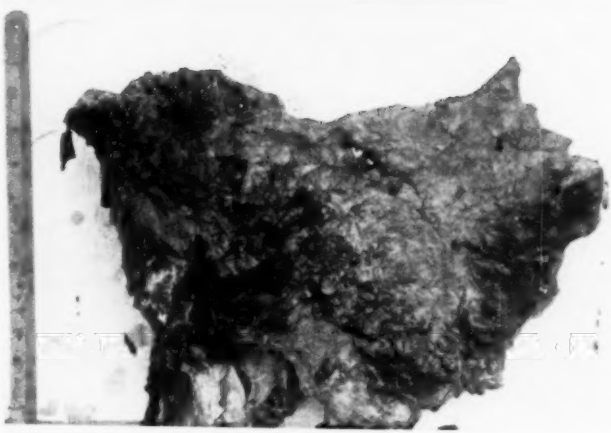

FIG. 6

Zone of calcification, approximately 25 x 2[illegible] cms. in size, from the liver of a Fin whale.
(Photo C. E. Ash)

(Article by Cockrill, page 133)

(*a*) A 25-metre female Blue whale. Five specimens were found free in the folds of mucous membrane in the small intestine. Infestation was slight and there was no evidence of inflammation or other damage.

(*b*) A 26.5-metre Blue whale. Sixteen specimens from the small intestine were obtained. Infestation was heavy but again no visible lesion had been produced in the intestine.

The length of these specimens varied from 5.1 mm. to 140 mm.

NEMATODA : Family *Ascaridae*.

(1) *Anisakis physeteris*, Baylis, 1923.

Host: Sperm whale.

(*a*) A 16-metre male Sperm whale. Several specimens were discovered in the intestine. Infestation in this site was slight and there was no evidence of damage, or tissue reaction.

(*b*) A 15.5-metre male Sperm whale. Seven specimens were recovered from the first portion of the compound stomach. The degree of infestation was very heavy, but there was no evidence of damage.

(*c*) A 16.5-metre male Sperm whale. Four specimens were recovered from the intestine. Infestation in this site was slight and there was no evidence of damage.

These parasites measured 78 mm. to 130 mm. in length, and some of the female specimens have a greater length than any hitherto recorded. Their presence has not previously been reported in the intestine, from which site they were recovered alive.

Infestation of the stomach of Sperm whales is invariably very heavy. It is estimated that the weight of parasites in the first portion of the stomach may approximate to 50 kg. No evidence of local damage or general detriment has been observed and it appears possible that these nematodes are commensals, or that they play some specific part in the preparation of the ingesta for digestion.

Family *Spiruridae*

(2) *Crassicauda crassicauda* (Creplin, 1829), Leiper and Atkinson, 1915.

Host: Fin whale.

(*a*) Five specimens, caudal extremities only, from the ureter of a Fin whale.

(*b*) and (*c*) Portions of infested kidney from two Fin whales.

The posterior portions of these filarial worms lie free in the kidney tubules, the anterior ends being embedded in a complex mass of connective tissue and adopting a course so tortuous that it is extremely difficult to dissect out an entire specimen (Baylis, 1922). The tissue reaction leads to the formation of connective tissue masses (Hamilton, 1916).

This parasite has been reported as occurring in both baleen and toothed whales (Baylis, 1916). The author has observed the characteristic kidney lesions in many Blue, Fin and Sperm whales in both the Ross Sea and the Weddell

Sea areas. Infestation appears to be common and widespread. The kidney lesion is characterized by greenish areas of caseation and, in old-standing cases, by calcification. The areas of caseation are found to be heavily infested with *Crassicauda*. Hyperaemia has been noted in the secondary urinary ducts in association with the presence of this parasite and is thought to be the first stage in the complex tissue reaction which leads eventually to the formation of a calcareous rhizoid mass.

Histological examination at the Weybridge Veterinary Laboratory of a number of these lesions collected by the author during the 1951/52 whaling season, showed that the early tissue reaction consists of massive infiltration of the surrounding tissues by eosinophiles and neutrophiles. Later, fibrosis occurs followed by calcification. The area is then a mass of acute and chronic tissue reaction with calcification and foreign-body granulomatus tissue. In the early stages of infestation subepithelial capillary hyperaemia is observed in the urinary ducts. This progresses to a chronic inflammatory reaction with calcification around the remnants of the parasites. There may be several lesions in one kidney and these may be as large as a football and weigh 5 to 6 kg.

The parasite is primarily one of the uro-genital system. Baylis and Bennett (1922), describe a specimen of *Crassicauda in situ* in the penis of a Fin whale. Hamilton (1916) describes the extension of digitate lesions to the renal vein. Rewell and Willis (1949) comment on a lesion from the " Discovery " collection in which an adult female worm, full of ova, appeared to be the source of a large, branched and calcified thrombus in the inferior vena cava of a Fin whale.

Such invasion of the blood system would make possible the transference of infestation to other parts of the body by metastasis, and the author considers that many of the lesions occurring in other parts of the whale's anatomy, and in which caseation and calcification together with the abundant formation of fibrous tissue are notable features, may have an origin in *Crassicauda* infestation. Closely similar lesions were observed by the author in the pancreas and lung of Fin whales in the Weddell Sea during the 1948/49 season.

A large irregularly-shaped lesion was recovered from the liver of a 19-metre male Fin whale in the Ross Sea. It took the form of a thrombus weighing 1.25 kg., encapsulated and exhibiting calcification and caseation, and lying within the portal artery. Macroscopically the lesion resembled *Crassicauda* infestation but no trace of parasites could be discovered. Histological examination showed the mass to consist mainly of collagenous fibrous tissue with no apparent blood-vessels and sparse fibroblasts. Although intimately united with the wall of the artery the line of demarcation was indicated by the absence of elastic fibres in the lesion and their presence in the vessel.

ACANTHOCEPHALA

(1) *Bolbosoma hamiltoni*, Baylis, 1929.

Host: Fin whale. Five specimens were recovered from the large intestine of a female Fin whale. Infestation was heavy. These parasites abounded

in the folds of the mucosa. Length varied from 50 mm. to 64 mm. The anterior extremity was deeply embedded. In each case a small region of raised tissue surrounded by an area of inflammation marked the site of insertion. The irritation and damage to the intestinal wall of the host caused by a heavy infestation with this parasite is very considerable.

(2) *Bolbosoma porrigens* (Rud., 1814), Porta, 1908.

Host: Humpback whale. Twenty-one specimens were recovered from the large intestines of two Humpback whales in the Ross Sea area.

(*a*) A 14.5-metre female Humpback whale. Twelve specimens were obtained from the reticulate large intestine ; three were not detached from the intestinal wall.

(*b*) A 12.8-metre female Humpback whale. Nine specimens were obtained from the reticulate large intestine.

In both instances infestation was very heavy. The colour of this parasite ranges from pale pink to bright red. The average length was 101 mm. This species is very difficult to dissect out, the anterior end being deeply and tortuously embedded in the intestinal wall.

The size of the whale is such that it is difficult to assess the systemic effect of heavy infestation by tapeworms or other parasites. No emaciated whale was observed and no adverse effect seems to result other than such local evidences of irritation and inflammation as occur in the case of *Bolbosoma hamiltoni*. Stolk (1953) has described a case of colitis in a Blue whale in which the abundant formation of connective tissue and the presence of necrotic masses were features. It appears probable that the lesion was parasitic in origin.

Tumours

Tumours of various kinds have been observed and reported in whales in the past. None appear to have been truly malignant in character and in no case has metastatic spread been noted. Slijper (1949) and Stolk (1950) report the occurrence of a fibromyoma 45 × 50 cm. in the uterus of a lactating Blue whale. The tumour contained a large amount of fat, and some small patches showed calcification. Slijper suggests that the fibromyoma had caused an abortion about three months previously.

Rewell and Willis (1949), reporting on a number of specimens in the "Discovery" collection at the British Museum, describe a benign fibromyoma from a whale of unknown species. This body was a circumscribed mass, 4 cm. in greatest diameter, and attached by a short pedicle. A mucinous cystadenoma from the ovary of a Blue whale is described. This specimen consisted of one half of a multiloculate cystic tumour about 30 cm. across. An apparently similar, though smaller, specimen was recovered by the author from a Blue whale, precise site unknown, in the Ross Sea area (Fig. 2).

In the "Discovery" collection three growths from the ovaries of a Blue and two Fin whales were classified as granulosa-cell tumours. Two of these measured 3 cm. and 3.5 cm. across, respectively. The size of the third had not been noted.

A papilloma of the tongue of a Blue whale was about 8 cm. in diameter and showed the typical structure of a benign squamous-celled papilloma. The authors comment that the structure of all six tumours examined is similar to that of tumours of these types observed in other mammals.

The specimen of ganglioneuroma found in the anterior mediastinum of a Blue whale is described by Rewell and Willis (1950) as having a similar structure to that of benign ganglioneuroma in the human subject. The size of the complete specimen was not known.

Stolk (1950) reports a case of carcinoma of the left ovary in an old Fin whale, which he considers to be practically identical with ovarian carcinoma of the human subject. The tumour consisted of a nodule 3 cm. in diameter. Localized regions of calcification were present as a result of cell degeneration in the older parts of the growth.

Stolk (1952) further records a typical fibroma of the skin of the lower jaw of a male Sperm whale. This tumour measured 48 × 45 × 19 mm. Fibroma of the skin of a Fin whale (30 × 30 × 15 mm.); fibroma of the tongue of a Fin whale (55 × 44 × 29 mm.), a firm, pedunculated warty tumour; and fibroma (75 × 65 × 65 mm.) of the tongue of a Humpback whale, are also described. The histological structure of these tumours resembles their counterparts in human pathology.

A description of tumours collected by van Lennep on the floating factory "William Barendsz," during the 1950/51 and 1951/52 seasons is given by Stolk (1953). A fibroma of the skin of the lower jaw of a Humpback whale (30 × 29 × 22 mm.) showed on the surface an extensive ulceration with many inflammatory cells and areas of necrosis. A fibroma of the skin of a Fin whale (about 55 × 85 mm.) contained foci of necrosis. A fibroma (13.5 × 26 × 45 mm.) of the skin near the blow hole of a Sperm whale, and a verruca (8 × 12 cm.) between the eys of a Sperm whale are described. Haemangioma in the liver of a Sperm whale (20 cm. in diameter) revealed the typical structure of the cavernous haemangioma of the liver in human pathology.

From the utilitarian viewpoint the presence of small and obviously benign neoplasms is of little importance compared to other technical matters which may occupy the attention of an observer. It is, perhaps, for this reason that such lesions tend to be overlooked or incompletely documented. The writer included in his collection of specimens from the 1948/49 season a lipomatous tumour from the Longissimus dorsi muscle of a Fin whale. Microscopic examination showed this to be a mass of adipose tissue with a thick fibrous capsule, but a scanty stroma. This type of lesion is particularly common.

The normal deposition of visceral fat frequently assumes peculiar forms and shapes and it is common to find on the serous surface of the stomach, around and on the spleen, and throughout the omentum, pedunculated balls and elongated rolls of encapsulated fatty tissue. Histological examination of such lesions confirms that they are adipose tissue, and invariably encapsulated. Fig. 3 shows one such lesion which was situated on the serous surface of the liver of a 25-metre pregnant Blue whale. This was a freak specimen in that the "knot" at the end of it was entirely natural. Blood vessels were numerous and the state

of vascularity, for a lesion of this type, was high. A similar lesion, 5 cm. long, was found on the serous surface of the small intestine of a 25-metre Blue whale.

A round, pedunculate growth from the serous surface of the stomach of a 26-metre female Blue whale in the Ross Sea area was approximately 5 cm. in diameter, fibro-lipomatous in character and encapsulated.

From the foregoing brief survey of recorded neoplastic bodies in whales, two facts emerge. One is the extremely small size of all these bodies in relation to the enormous bulk of the affected animal. The other is the apparently benign character of all tumours so far reported. Many of these growths appear to be retrogressive. No metastatic spread has been noted. Interference with health or with the performance of any of the body functions appears extremely unlikely. Rapidity of growth, migration and transplantation, and any of the characters of malignancy appear to be entirely lacking. The tendency is to encapsulation, and the ready formation of fibrous tissue.

Abscess Formation

The commonest type of abscess in the whale and, in the author's experience, probably the commonest pathological lesion of the Cetacea, takes the form of a smooth, encapsulated, generally round or ovoid body, varying in size from a diameter of 1.5 cm. to one of 70 cm. and weighing up to 68 kg. These bodies may be found singly or in groups almost anywhere within the body of the whale. They have been commonly noted in Blue and Fin whales in both the Weddell Sea and the Ross Sea areas, and are sometimes colloquially referred to as " husks."

The commonest site is the Psoas muscle and one or more husks may be found within a pocket in the substance of the muscle. As many as 36 bodies have been noted (Fig. 4). The pocket has a smooth fibrous lining. It may be very large ; McIlroy (1949) noted a pocket 1 metre in length and Addison (1950) described a lesion measuring $3 \times 0.6 \times 0.03$ metres. The inner lining was white and the cavity contained clear, serous fluid and numerous small, white, oval husks.

The husks are to be found also in the Psoas muscle sheath lying just underneath the blubber. Frequently they are found loose in the abdominal cavity but these are thought to have been dislodged from the original site during flensing or lemming. They have been observed by the writer in the substance of the Longissimus dorsi muscle, in the musculature in the vicinity of the eye, and in the muscular tissue of the throat region. In the latter case a single body was discovered attached loosely to the trachea and oesophagus and weighing 68 kg.

The bodies may be found singly in muscle tissue without the pocket formation. Many of them may be observed in a small muscle area. They are uniformly of a hard, rubbery consistence, invested by a tough fibrous capsule which occasionally shows traces of fibrous attachment to the pocket, or muscle site.

On incision, the husks contain an impacted yellowish material which resembles inspissated pus. Caseation and calcification are often observed. Frequently the contents are completely calcified. Sometimes they are gritty, or they may consist of a multitude of minute, hard, yellow pellets. Occasionally a small quantity of clear serous fluid is present.

Samples of husks, collected by the author, have revealed the following on histological examination.

(1) From the abdominal cavity of a 24-metre male Blue whale in the Ross Sea area; a dark-red, ovoid body, 10 × 5 cm., showing fibrous attachments, and having an avascular, acellular, fibrous capsule containing an eosinophilic, amorphous, granular substance.

(2) A small, round, white body, 1.5 cm. in diameter, found lying free on the visceral surface of the liver of a 26-metre female Blue whale. A dense fibrous capsule surrounded solid, calcareous material which, after decalcification, appeared in section as an amorphous, granular, eosinophilic substance containing many scattered neutrophile polymorphonuclear leucocytes.

(3) A flattened oval body, 8 × 5 cm., found loose in the abdominal cavity of a 25-metre female Blue whale in the Ross Sea area. This consisted of a tough, fibrous, connective tissue capsule enclosing very loose connective tissue. From the same whale two small round bodies, 2 cm. in diameter were discovered attached to one of the ovaries. The hard fibrous tissue capsule enclosed a much denser fibrous connective tissue containing bands of unstriped muscle fibres and penetrated by a well-developed blood vascular system. These lesions, though similar in outward appearance, bear little resemblance histologically to the bodies known as "husks."

(4) A white, rounded body, 4 cm. in diameter, from the musculature of the head region of a Blue whale, and two similar bodies from the Longissimus dorsi muscle of the same whale caught in the Weddell Sea area. Microscopically, these showed amorphous, granular, eosinophil material, containing scattered nuclear fragments, a few leucocytes — mainly eosinophiles — and the remains of erythrocytes.

It is considered by the writer that these lesions may be degenerated intermediary stages in the life cycle of internal parasites. Almost all lesions in the whale are invested and isolated by thick, hard, reactive, protective, fibrous connective tissue. This investing membrane would appear to be capable of assisting, if not actually bringing about, the process of degeneration.

Other Lesions and Inflammatory Processes

Occasionally, deposits which appear macroscopically to be of a fibrous or fatty-fibrous nature are to be seen on, or within, the serous surfaces of liver, lungs, stomach and other organs. They vary in area up to about 4 cm. square and often they are very numerous. The deeper layers of tissue are unaffected and there is no evidence of inflammation or adhesions.

(1) From the visceral surface of the serous coat of the liver of a Fin whale: on microscopical examination this consisted of fibrous connective tissue containing various amounts of adipose tissue.

(2) From the base of the left lung of a 25-metre female Blue whale (Fig. 5); microscopically these appeared as very loose connective tissue with spaces occupied by fat.

(3) A fibrous deposit from the endocardium of the left ventricle of a 24-metre male Blue whale: microscopically the focal thickening consisted of fibrous connective tissue containing sparse fibroblasts and covered by endothelium.

(4) A small fibroid patch on one of the ovaries of a 26-metre Blue whale: on microscopic examination this lesion consisted mostly of collagen fibres and was thought to represent an organized corpus luteum.

The above lesions may have little or no pathological significance, though their appearance would frequently suggest a parasitic origin. They are common in Blue and Fin whales taken in the Weddell Sea and the Ross Sea areas. It may be that they represent a manifestation of the mechanism for the storage of fat.

Deposition of myxomatous tissue was noted on the serous surface of the stomach of a Blue whale.

Nodules of various sizes, up to 2 cm. in diameter, have been observed, sometimes in great numbers, on the serous surface of the intestines. These were observed by the writer on several occasions in Blue whales in the Weddell Sea area. The general appearance may give rise to a suspicion of tuberculosis but smears stained by the Ziehl-Neelsen method invariably failed to reveal the presence of acid-fast organisms. Histological examination of several such specimens showed them to consist of concentrically-arranged collagenous fibrous tissue, occasionally surrounding a necrotic core suffused with old erythrocytes. The whole lesion may be embedded in a mass of fibrous tissue. They may represent a chronic purulent process and are considered to be the end stages of multiple small abscesses probably of parasitic origin.

Similar lesions have been seen in the muscle tissue of the pectoral region in a Blue whale taken in the Weddell Sea area.

A case of chronic inflammation of muscle tissue near the atlas of a Blue whale has been described by Stolk (1953), nodule formation was again a feature, with the presence of necrotic masses and some local calcification. Fibroblasts and collagenous fibres showed a whorled structure.

In a Blue whale in the Weddell Sea a large zone of necrosis was noted by the author in the muscle tissue of the lumbar area. Microscopically there were large necrosed muscle fibres undergoing phagocytosis and separated from one another by an intense inflammatory reaction with giant cells. Fibrous tissue formation was seen on the edges of the lesion. Stolk (1954) has noted inflammation with necrosis and deposition of lime in the intercostal musculature of a Fin whale.

The occurrence of Trichinosis has been noted in several Arctic mammals including the Right whale (Roth, 1949; Anon. Public Health Report, 1951). It is possible that this condition has accounted for loss of life from undiagnosed causes in dogs and man in early exploration expeditions to the North. It has not to date been reported as occurring in Antarctic regions.

The mammary glands of whales exhibit a wide variation of size, colour and texture depending on the age, the stage of sexual maturity, and whether or not the whale is pregnant and/or lactating (van Lennep and van Utrecht, 1953). A case of acute mastitis was observed in a lactating Blue whale. Both glands were greatly enlarged and firm in consistency. The milk was markedly bloodstained. A wide range of colour of the glands has been seen by Japanese workers (Omura,

1947; Nishiwaki and Oye, 1948; Mizue and Murata, 1952).

Stolk (1953) has commented on a case of chronic, non-specific tonsillitis in a Sperm whale, and again (1954) on fibro-papillomatous proliferations of the pleura in a Blue whale.

Occasionally abnormalities in the liver are noted. Stolk (1953 and 1954) described cirrhosis in a Blue whale. Liver lesions have been noted by Cockrill (1949 and 1951), McIlroy (1949) and Addison (1950). Petechial haemorrhages have been noted by the writer on the surface of the liver of a Blue whale caught in the Weddell Sea. This condition was not identified by macroscopic means but on histological examination acute, diffuse, degenerative changes in the hepatic cells were seen. The capsule of the liver was thick and focally it was suffused with erythrocytes.

A Fin whale from the Weddell Sea area exhibited a typical severe cirrhosis, the fibrous tissue formation being very dense with fibres arranged concentrically around spaces in the liver substance. Diffuse necrotic lesions were observed in the liver of a Blue whale from the same area.

A further cirrhotic lesion came from a 26.5-metre female Blue whale caught in the Ross Sea area. The affected liver area was about 30 cm. square and a marked formation of fibrous tissue extended into the tissue for a depth of 5-8 cm. Otherwise the liver was normal and showed no evidence of parasitic infestation. On section, marked cirrhosis was evident with a few recent haemorrhages and a small amount of haemosiderosis. Surviving hepatic cells were normal. The cause of the lesion could not be ascertained.

A large lesion from the liver of a Fin whale (length and sex not recorded) caught in the Ross Sea was approximately 60 cm. square. It was tough, friable, and of patchy appearance. Histologically, the hepatic structure was completely disrupted, cells lying erratically, singly or in pairs. There was much desquamation of bile duct epithelium and marked fibrous overgrowth of the portal tract. No evidence of parasitic infestation could be discovered.

On several occasions, in both Blue and Fin whales in the Weddell and Ross Sea areas, the author has observed extensive zones of calcification within the liver substance. The calcified tissue is porous, brittle, dark in colour, and has a powerful and unpleasant odour. The men whose job it is to cut the liver into pieces before it is fed into the mincer, report that such lesions are of frequent occurrence. The calcified structure is irregular in shape and may be very large (Fig. 6). It is considered that such calcification may be the end-point of a large thrombus of bacterial or parasitic origin. The structure is often such as to suggest a foreign body, and there is a lack of the fibrous tissue which is produced so liberally in most pathological or traumatic lesions in whales.

No evidence of jaundice has yet been recorded in whale tissue. In the normal healthy whale there is an abundant production of bile which is frequently sufficient to stain the intestinal contents bright green for a length of several metres. Pigmented blubber is reported occasionally and may cause the processed whale oil to bear a red tinge (Brachi, 1953), but no evidence has been disclosed that this is associated with any pathological condition of the liver.

(Part 2 to be published in May, 1960)

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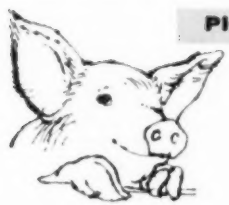

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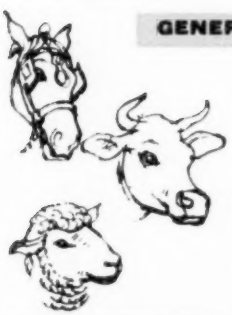

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1955	Rastinon	1910	Arsphenamine
1948	Normethadone	1906	Epinephrine
1945	Methadone	1905	Procaine
1939	Pethidine	1897	Amidipyrine
1931	Tetracaine	1892	Diphtheria Anti-toxin
1923	Mersalyl		
1922	Rivanol	1884	Phenazone

HOECHST

VESICAL SCHISTOSOMIASIS IN THE DOMESTIC PIG

By D. H. HILL[1], D.M.M. (Toronto) and
S. D. ONABAMIRO[2], B.Sc.(Man.), Ph.D.(Lond.), F.L.S.

Cases of schistosomiasis in domestic animals have been reported from many parts of the world, including Europe, Asia, North and South America and Africa. The animals most commonly affected are cattle, goats, sheep, camels, horses, asses, dogs, rabbits and occasionally cats. Among wild animals cases have been reported in antelope, zebra, and monkeys (Lapage, 1956) and experimental infection has been produced in many of the smaller wild animals, including opossums, capybaras, hutias and peccaries (Torrealba *et al.*, 1958). Cawston (1933) has described schistosomiasis in South African stock. Wu (1938) described *Schistosoma japonica* infection in sheep and goats and reviewed the reservoir hosts of this parasite in China. Berghe (1939) presented a comprehensive review of schistosomes and schistosomiasis in man and in cattle in the Belgian Congo and Ruanda Urundi. Rao (1939) submitted a short review of schistosomes of domestic animals and their molluscan hosts in India. Raper (1951) described a case of *Schistosoma bovis* infection in man in East Africa. An extensive review of the biology of the schistosome complexes in Africa and elsewhere has been published by Kuntz (1955).

Reports of any form of schistosomiasis in swine are few. Magath and Mathieson (1946) have demonstrated the ability of *Schistosoma japonicum*, the schistosome parasite of man in the Philippine Islands, to establish itself in a number of domestic animal hosts, including the pig. Rao and Ayyar (1953) reported on what they called a case of *Schistosoma suis* nova sp. found in the portal veins of apparently healthy pigs slaughtered in Madras and commented on the dearth of literature on porcine schistosomiasis. Pinto (1944) was unable to produce experimental infection in pigs with *Schistosoma mansoni*, the cause of intestinal schistosomiasis in man, although a more recent report by Riggin and Berrios (1956) in Puerto Rico describes a successful attempt to produce experimental infection in pigs with this parasite. These workers did not, however, find any pigs naturally infected with schistosomiasis in Puerto Rico. Maegraith (1958), on the other hand, discusses the problem of schistosomiasis in man in China and states that the "coprophagous pig" can pass viable ova of *Schistosoma mansoni* after eating infected animals and thus acts as a carrier of this disease. Torrealba *et al.* (1958) after successful experimental infection of the peccary, *Pecari tajacu* Torvus, a wild member of the family Suidae, in Venezuela, with *Schistosoma mansoni*, considered it necessary to investigate the peccary from endemic regions of the disease in order to prove its role as a disseminator of this parasite.

The case to be described in this paper concerns the natural infection of the domestic pig with vesical schistosomiasis caused by a parasite, the ova of which

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were, or closely resembled, those of *Schistosoma haematobium*, the cause of human vesical Schistosomiasis, or Bilharziasis. The present authors have found no previous reference to vesical schistosomiasis in swine in any part of the world and no reference to any form of schistosomiasis in swine in Africa.

Case 1 — Large White Boar

On 9th November, 1954, a 30-month-old stud boar was observed passing thick, bloody urine. The temperature was 100.8°F. There were no other symptoms. As he refused to serve any of the sows, trauma was suspected and he was placed under observation. Urine samples collected over the next few days showed blood cells, cellular debris and occasional dead spermatozoa. Differential blood counts were neutrophiles 47 per cent, lymphocytes 50 per cent, monocytes 1 per cent and eosinophiles 2 per cent. Urine samples examined on 11th December, 1954, contained occasional schistosome ova morphologically identical with, or closely resembling, those of *Schistomosa haematobium*.

As a one-sire line-breeding programme had been adopted for the University College, Ibadan, swineherd, it was decided to endeavour to treat the boar so that he could be put back into service. Accordingly, on 13th December, 1954, he was put on a course of treatment with Nilodin* (1-diethylaminoethylamine methyl-thioxanthone hydrochloride), used for the treatment of this disease in man, six ground tablets (1200 mgm.) daily in a drench for three days and three tablets (600 mgm.) for one day. The tablets were given in drench form as the boar refused to take them mixed in the grain ration. The urine was examined daily during the week following treatment, and by 17th December, 1954, all traces of blood and schistosome ova had disappeared. The boar was put back into service on 15th March, 1955, and subsequently sired healthy litters. It was decided to slaughter him on 1st June, 1956, due to poor hock conformation, this decision having no bearing on his earlier infection with schistosomes.

Lesions

No gross lesions were found other than for occasional pin-point hæmorrhagic foci in the mucosa of the urinary bladder. No adult schistosome flukes were found. Histopathological examination of the liver, gall bladder, lungs, heart, spleen, kidney, urethra, urinary bladder, testicles and inguinal lymph nodes were also negative.

Case 2 — Tamworth Sow

The second case occurred in a 24-month-old Tamworth sow, also from the College herd. On the evening of 6th July, 1958, she was observed passing bloody urine. Rectal temperature was 103.4°F. There were no other symptoms. On 7th July, 1958, several schistosome ova were found in the urine. When these were examined under the microscope they were found to be of the *haematobium* type, each with a conspicuous terminal spine. On the average the eggs measured 136.7γ long and 57.12γ wide at their widest portion. None of the eggs contained a miracidium. Instead, each egg contained an agglomeration of cells closely

* *Burroughs Wellcome Laboratories.*

packed together but leaving an empty space at either pole. This agglomeration was relatively dense at the rounded ends of the poles (Fig. 1).

To make sure that there were no viable eggs the centrifuged content of the urine was diluted with fresh water and poured into a narrow glass jar. This was carefully examined for the presence of miracidia. None were found.

Haematuria continued until 22nd August, 1958, when it was decided to slaughter the sow for investigational purposes. No treatment for schistosomiasis was at any time given to this animal.

Lesions

The only gross lesions found were two abscesses, one fist-size and one knuckle-size, in the right and left psoas muscles, respectively, opposite the first lumbar vertebra. Laboratory examinations of these abscesses showed cellular debris and diphtheroid organisms. No adult schistosome flukes were found in the viscera.

Tissues from all the viscera of this animal were sectioned and stained by haematoxylin and eosin.

In one piece of lung, a number of degenerate bodies of a size and shape compatible with schistosoma ova were found (Fig. 2). It was impossible to identify the position of the spine. These appeared to be undergoing early calcification and there was a slight foreign body reaction with the formation of multinucleated giant cells present. No evidence of fibrosis or of acute inflammatory reaction was present. No ova were found in any of the other tissues examined.

As soon as the infection was established a careful search was made for possible snail carrier hosts of *Schistosoma haematobium* in the grounds of the piggery. None were found in the piggery itself, but a large number of *Physopsis africana* snails were found by the side of a little stream in the College Botanical Garden which is situated about two hundred yards away from the piggery and on slightly lower level. *Physopsis africana* were also found near a village soak-away pit immediately beyond the periphery of one of the piggery paddocks.

Having failed to obtain viable eggs from the Tamworth sow it was decided to attempt to infect some pigs experimentally with the cercariae of *Schistosoma haematobium*.

Two hundred young *Physopsis africana* were placed in a tank of water containing miracidia hatching from eggs of *Schistosoma haematobium* obtained from school children at Epe, a town located on the Lagos Lagoon creek, approximately 60 miles from Ibadan, in an area endemic to schistosomiasis. Forty-four days later, five snails were observed to be discharging cercariae. The hind limbs of Pig No. 443, a 3-month-old Large White weaner, were immersed in a bucket of water containing these cercariae for a period of 30 minutes daily for four days, and Pig No. 445, also three months old, was treated in the same manner for four days. The infected snails, however, gave a poor cercariae discharge, and they all died within a week.

As from four weeks later the urine of these pigs was examined daily for schistosome eggs. None, however, was found. Sixty-two days after the first

immersion in water, both pigs were slaughtered, and the veins of the abdominal viscera, including the vesical veins, were examined for adult schistosomes. None was found. The failure of this experiment could be attributed to the small number of cercariae emerging from the *Physopsis* snails.

Discussion

This case is of interest since it shows, firstly, that the domestic pig can contract the urinary or vesical form of schistosomiasis and, secondly, that the ova of the causal parasite were morphologically similar to those of *Schistosoma haematobium*, the cause of vesical schistosomiasis in man.

Symptoms in the boar, other than for the periodical passing of thick, bloody urine, were not severe, but he did refuse to serve the sows. Treatment with Nilodin produced recovery in about a week and the boar was later put back to successful stud use. The sow, which received no treatment, was slaughtered for investigational purposes, so that it was not possible to observe the effect of infection with vesical schistosomiasis on her breeding performance.

Attempts to hatch the ova voided in the urine from the sow were unsuccessful, likewise, attempts at experimental infection of young pigs with *Schistosoma haematobium* by exposing them to the cercariae of this parasite were without success. The number of attempts to infect pigs with *Schistosoma haematobium* was small, however, and should be repeated, using also a heavier challenge of cercariae.

The source of this infection is debatable. Assuming that the causal parasite was *Schistosoma haematobium*, and from the shape of the ova found there seems little reason at the moment to doubt this, infection was most likely spread from inhabitants of the village near the piggery paddocks.

At the moment of writing (June, 1959) two boys in a primary school in this village are suffering from vesical schistosomiasis, and at the time of conducting this investigation there were about half-a-dozen pupils of this school who had this infection.

The schoolboys occasionally crossed the stream in the Botanical Garden adjacent to the piggery to collect palm leaves for making baskets and brooms. It would not be unusual for these boys to urinate along the stream and so deposit schistosome eggs. *Physopsis* snails in the Botanical Garden stream and also in the village soak-away pit on the periphery of the piggery paddocks could thus have become infected. Though none of the snails collected were infected with *Schistosoma haematobium* it seems very likely that those snails constituted a possible source of infection to the breeding stock in the piggery since these animals were allowed access to the paddocks for grazing and exercise.

As stated above, the ova voided in the urine of the Tamworth sow were non-viable, the embryos failing to develop to the miracidium stage. From the scant evidence presented in this one case, therefore, it would not appear that the domestic pig might serve as an important intermediary host for *Schistosoma*

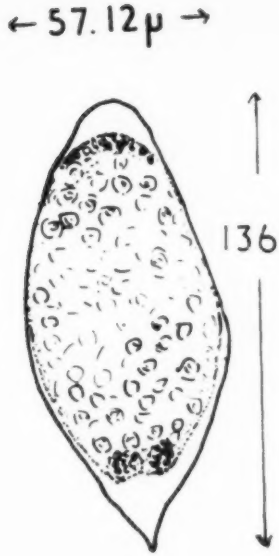

FIG. 1
Non-viable egg of Schistosoma haematobium from Pig Ibadan, Nigeria.

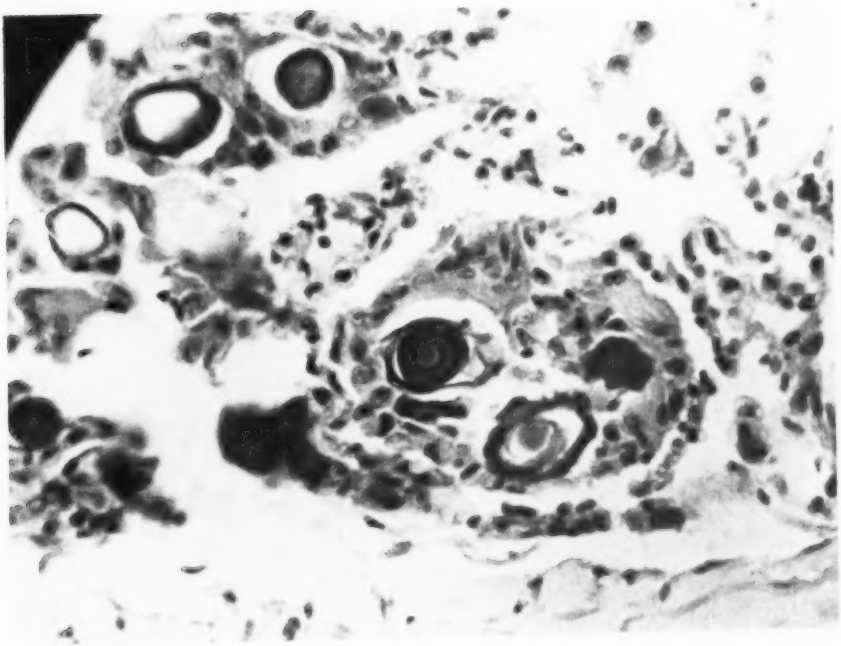

FIG. 2
Lung Tissue. Mag. 300.

(Article by Hill, page 145)

haematobium in Nigeria, unlike Maegraith's findings with *Schistosoma mansoni* infection in swine in China (vide supra). In the case of experimental *Schistosoma mansoni* infection of swine by Riggin and Berrios (1956) in Puerto Rico, referred to earlier in this paper, the infection appeared to have little or no effect on the health of the carrier pigs. In the case of the boar infected with vesical schistosomiasis, described in this paper, however, the animal refused to serve until curative therapy had been applied, which suggests that under certain conditions in Nigeria the vesical form of the disease could be a swineherd problem.

Summary

A case of natural infection of a Large White boar and a Tamworth sow with vesical schistosomiasis caused by a parasite, the ova of which were, or closely resembled, those of *Schistosoma haematobium*, the cause of vesical Schistosomiasis, or Bilharziasis in man, is described. Adult schistosome flukes were not found. The authors were unable to find any other reference to vesical schistosomiasis in swine, although infection in swine with other schistosomes was noted. Haematuria and unwillingness to serve were the chief clinical symptoms in the boar, which responded later to treatment with Nilodin, used for the treatment of this disease in man, and was put back into service. Haematuria also occurred in the sow, which was not treated. All ova voided in the urine were non-viable, so that re-infection of experimental animals could not be attempted. Attempts at experimental infection of the pig with cercariae of *Schistosoma haematobium* from human cases were also unsuccessful. From the scant evidence presented it would not appear that the domestic pig might serve as an important intermediary host for *Schistosoma haematobium* in Nigeria, authough the disease could, under certain conditions, be a swineherd problem

Acknowledgments

The authors are grateful to Dr. J. J. C. Buckley, London School of Hygiene and Tropical Medicine, and to Dr. J. M. Watson, Director, Commonwealth Bureau of Helminthology, St. Albans, for their interest shown in this case and help with references ; to Dr. J. G. Jackson, Senior Lecturer in Pathology, University College Hospital, Ibadan, Nigeria, fo preparation and comments on histological sections ; to Mrs. Lisbeth Leich and Mr. O. Udoh in the laboratory ; to Mr. R. Myhill, Senior Technician, Faculty of Agriculture, University College, Ibadan, for preparing microfilms ; to Messrs. A Nneke and E. Adepoju, of the Piggery staff ; to Mr. E. Ben Kalango and Mrs. Anita Pierce, for typing ; and to Professor R. J. McIlroy, Dean of the Faculty of Agriculture, University College, Ibadan, for reading through the manuscript.

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NECROSIS OF THE TAIL IN THE BUFFALO
A DEFICIENCY DISEASE?

By

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Introduction

Tail necrosis "Arrada" is a chronic disease observed only among Egyptian buffaloes. It has not been noticed in cattle even when they are kept under similar conditions. Its onset is marked by loss of hair at the tip of the tail followed by hyperkeratosis. Later on, necrosis sets in. If no treatment is applied, the necrosis spreads slowly and gradually upwards to the base of the tail and finally the buffalo is deprived of its tail. This disease is of some economic importance since it causes an appreciable reduction in the price of the affected buffalo.

Recently El-Mekkawi (1958) claimed that *Corynebacterium bovis*, isolated among various organisms from diseased tails of buffaloes, was the causative organism. He claimed also that an effective method of treatment was to dip the affected tail in 10 per cent. formalin on several occasions at intervals of 10 days.

The fact that no infection is transmitted from diseased to healthy buffaloes, even if they are kept in contact with each other, has stimulated our interest to reinvestigate the problem.

Experimental

Materials and Methods

(I) The animals used, for the purpose of experimentally inducing tail necrosis, were:—

(a) Albino rats kept at the Biochemistry Department, Faculty of Veterinary Medicine.

(b) Buffalo herds belonging to the Faculty of Agriculture, Ein-Shams University, Cairo.

(c) Buffaloes owned by the Dairy Station, Veterinary Service of the Egyptian Army at Pyramid Road, Giza.

(d) Individual buffaloes owned by private farmers.

All buffaloes under (b), (c) and (d) were affected with typical tail necrosis.

(II) The different methods of treatment applied on rats and buffaloes involved the use of:—

(1) Formalin solution containing 10 per cent. formaldehyde used once or twice according to El-Mekkawi's proposal.

(2) A mixture composed of linseed oil (30 ml.) emulsified with the yolk of one hen's egg and administered orally as a daily dose for one buffalo. It was prepared as follows:—
Twenty egg-yolks were introduced into a dry clean mortar (1 litre capacity). Then linseed oil (600 ml.) was added gradually and triturated well in one direction until the oil droplets disappeared completely. A pasty

Table I
Increase in Body Weight of Rats Fed on Diet (A)

Rat No.	Weight of the rat in grammes recorded once per week													
	8.3.1958	15.3.58	22.3.58	29.3.58	5.4.58	12.4.58	19.4.58	26.4.58	3.5.58	10.5.58	17.5.58	24.5.58	31.5.58	7.6.58
1	155	165	170	175	180	190	195	200	205	215	220	225	230	240
2	155	160	165	170	170	175	180	185	195	195	200	205	210	220
3	135	150	160	170	175	180	190	195	205	210	230	230	235	240
4	145	160	165	175	175	185	195	210	215	220	220	225	225	230
5	105	115	125	130	135	135	140	140	145	150	155	160	165	170
6	110	120	135	135	140	140	150	160	170	175	180	190	195	200

uniform emulsion was obtained and this was placed immediately in a clean, dry and dark stoppered pot. The emulsion was kept in the ice-chest ready for use.

Production of Tail Necrosis in Rats: Experiments to produce dietary deficiency were carried in four groups of albino rats (A), (B), (C) and (D). Each group, comprising six rats, was placed in a separate cage and fed on one of the synthetic diets designated as (A), (B), (C) and (D) respectively as follows:—

Diet	(*A*)	(*B*)	(*C*)	(*D*)
Ingredients	%	%	%	%
Rice Starch ...	56	56	56	63
Casein	24	24	24	27
Cod Liver Oil ...	2	—	10	—
Linseed Oil ...	8	10	—	—
Yeast	5	5	5	5
Salt Mixture* ...	5	5	5	5

Water was supplied ad lib.

Diet (A) represented a complete diet.

Diet (B) was deficient in fat soluble vitamins.

Diet (C) was deficient in indispensable fatty acids but not vitamin A.

Diet (D) was completely free from fats.

The rats were examined daily to note any symptoms and weighed once a week. This experiment continued for three months.

Results

Diet (A) proved to be an adequate diet since rats remained healthy and showed a remarkable growth and an appreciable increase in body weight (Table I).

Rats fed on diet (B) showed symptoms of vitamin A deficiency in about 60 to 70 days ; notably keratinization of the epithelial tissues and xerophthalmia in two rats, but no tail necrosis. When diet (B) was fed together with the emulsion the symptoms completely disappeared in about two to three weeks.

Diet (C) proved to be deficient, since in about 70 to 90 days the rats showed scaly patches on the tail which became spotted, wrinkled and finally necrotic. The hair on the back became affected with dandruff and had a tendency to fall out. These rats were then given the emulsion to test its curative properties. In about 21 to 30 days the affected animals recovered and showed an appreciable increase in body weight and the hair appeared normal again (Fig. 1).

Diet (D) proved inadequate since the rats could not live beyond a period not exceeding 70 days. The rats at first developed a scaly condition on their tails which prevailed on other parts of the animal body also. Later on, the condition was accompanied by hæmorrhagic spots on the skin and ulcers on the eyes. The legs of the rats, especially the hind legs, became scaly and swollen. At last, the tail as well as the digits of the forelimb became necrotic and death occurred in the

* It was made according to the formula of McCollum-Davis salt mixture (*Practical Physiological Chemistry*, Hawk Oser Summerson. 12th Ed., 1947, p. 1274).

course of two months unless diet (D) was supplemented with the emulsion. The animals could be rescued if they did not reach a near fatal stage.

Two rats of this group fed on diet (D) for one month showed typical tail necrosis. The tip of the tail dropped and showed a circular fissure (Fig. 2).

These two rats were treated according to El-Mekkawi's proposal by dipping the affected tail twice in 10 per cent. formaline, but there was no improvement.

As the treatment with 10 per cent. formalin failed, the two rats were fed on diet (D) supplemented with the emulsion. Complete resolution of the two tails occurred in the course of 21 days.

This successful treatment of tail necrosis, induced experimentally in the rats by dietary deficiency, encouraged us to test the emulsion in the treatment of the disease in buffaloes.

Mode of Treatment: The emulsion was administered orally in doses of 30 g. per day for each buffalo. Its curative properties were so remarkable that all features of tail necrosis disappeared completely in a period varying from 21 to 30 days according to the severity of the case.

Two buffaloes suffering from necrosis were used to test the effect of 10 per cent. formalin, according to El-Mekkawi's method, and two other diseased animals were given the emulsion so as to compare between the two methods. The formalin method proved to be ineffective; only slight lesions or cracks on the tail disappeared whereas the condition in the other two buffaloes, which were given the emulsion, was resolved completely (Fig. 3).

Thereafter, a total of 35 buffaloes suffering from necrosis, of both sexes and of different ages, were given the emulsion. All made a complete recovery after 21 to 30 days.

In addition to the daily oral administration, the emulsion can also be applied externally after the tail has been cleaned thoroughly with soap and water. This helps to cut the time of resolution down to two weeks.

Discussion

El-Mekkawi (1958) attributed the cause of tail necrosis in the buffalo to *Corynebacterium bovis*. Two normal buffaloes were inoculated at the tip of the tail with this organism. Lesions developed after three days.

In our opinion the lesions obtained were the direct results of infection with the organism and that is why it was cured by the application of 10 per cent. formalin. Our experiments have shown that formalin failed to cure experimentally induced tail necrosis in rats or naturally occurring in buffaloes. Consequently El-Mekkawi's theory has not been confirmed, especially so as the disease was not transmitted when necrotic and healthy buffaloes were kept in contact with each other.

According to El-Mekkawi, the pathological changes consist of marked hyperkeratosis of the epidermis, consolidation and homogenisation of the connective tissue together with collapse of the blood vessels. The nature and general appearance of the changes are highly suggestive of interference with the arterial circula-

FIG. 1

Rat fed on diet (C) showing loss of hair after 75 days.

FIG. 1a

The same rat fed on diet (C) supplemented with the proposed medicine after 28 days.

(Article by Barakat, page 151)

PLATE V

FIG. 2
Rat fed on diet (D) showing tail necrosis after one month.

FIG. 2a
The same rat fed on diet (D) supplemented with the proposed medicine showing cure of the tail after 21 days. The tail was seized by a forceps because the rat was active.

FIG. 3
Tail necrosis naturally occurring in a buffalo.

FIG. 3a
The same buffalo showing cure of the tail after oral administration of the proposed medicine for 26 days.

(Article by Barakat, page 151)

tion responsible for nourishing the affected area. This obstruction leads to a sequence of progressive pathological changes manifested in the early stages by loss of hair at the tip of the tail and later by morbid changes in the sebaceous glands which finally lead to interference with the circulation.

Our experiments showed that rats, placed on diets (C) and (D) devoid of indispensable fatty acids, failed to grow and developed characteristic lesions of the skin and tail. When the emulsion was administered the deficiency symptoms disappeared. The inability of the animal body to synthesise certain highly unsaturated fatty acids essential for its normal nutrition was first demonstrated by Burr and Burr (1929). The emulsion provides such highly unsaturated fatty acids as linoleic and linolevic acids, present in linseed oil and arachidonic acid in the lecithin of the egg-yolk.

The necrosed tail usually shows eruptions which are liable to infection by micro-organisms. This may explain why El-Mekkawi has actually isolated not only *Corynebacterium bovis* but also a number of other bacteria from diseased tails. We believe that these organisms attacked an already necrosed tail.

There is no reason to believe that tail necrosis occurring naturally in the buffalo differs from tail necrosis induced experimentally in the rats as a result of dietary deficiency.

The emulsion has also the advantage of providing the necrotic buffalo with vitamin A, a deficiency of which usually leads to excessive keratinization of various mucous membranes (Wolbach and Howe, 1925). The inclusion of vitamin A may help in the successful resolution of tail necrosis.

Summary

(1) Tail necrosis induced experimentally in rats is described.
(2) It is suggested that necrosis in the buffalo is of the nature of a deficiency disease.
(3) A 10 per cent. formalin dip as proposed by El-Mekkawi does not cure tail necrosis naturally occurring in the Egyptian buffalo.
(4) An emulsion, consisting of egg-yolk and linseed oil, is recommended for the treatment of tail necrosis in the buffalo.
(5) Thirty-five cases of necrosis in buffaloes were resolved in about 21 to 30 days when the emulsion was administered orally. When the emulsion was applied topically the period of resolution was reduced to 14 days.

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OBITUARY

SIR ROBERT HUTCHISON, Bt., M.D., F.R.C.P.

Sir Robert died at his home, Thurle Grange, Streatley, on Friday 12th February. He was 88 years of age. He was acknowledged in the medical world as a superb clinician and a great teacher. He was a man of the old school, a gentle and kind doctor who could bring comfort and hope to those that were sick, and yet he was of the new school also and in the van of progress all his life. Rather austere in manner and aesthetic in appearance, he never had time for cant or humbug. Clinical signs and symptoms were signals which could be interpreted and lead one to the cause. It is not surprising that this man exercised a great and beneficial influence on medical thought and progress and that young men and women came from far and near to sit at his feet. The staff and students of the Royal Veterinary College who were stationed at Streatley during the evacuation period consequent on World War II, will remember him with gratitude and respect. When there was illness at Streatley he frequently came to the assistance of Dr. Leslie, and there is no doubt that his counsel was the means of restoring a number of seriously ill students to a state of complete resolution. He and Lady Hutchison took an interest in the R.V.C. students, who were often invited to and welcomed at the Thurle Grange on Sunday afternoons.

A great physician has passed on full of years and honour, but the mark that he made in the medical field will keep his memory green.

REVIEWS

AN INTRODUCTION TO VETERINARY PHARMACOLOGY. By Frank Alexander. 179 pages. Edinburgh: E. & S. Livingstone. 20s.

In the days of our fathers (and the more senior members of the veterinary profession), the student of materia medica spent much of his time learning the detailed composition of a host of preparations and, in doing so, committed to memory many 'odd odes' to assist him in this task. Many years have passed since veterinary surgeons in general practice compounded such preparations as tinct. opii—and the need for such 'learning' has long since passed.

Today, dispensing is, in the main, a lost art in so far as the busy practising veterinary surgeon is concerned and we now live in an era of drugs and preparations whose names are legion and which only tend to confuse not only the student, but also the graduate, with the multiplicity of proprietory names which the manufacturers use to identify their products. Thus it is not uncommon to encounter different names applied to a single drug which may also have its niche in the official pharmacopoeias and codices. It is very desirable that, in the teaching of veterinary pharmacology, much of the 'dead wood' should have been removed from the curricula, thus permitting principles rather than detailed knowledge to assume importance. Dr. Alexander had obviously this principle in mind when preparing this book and he has succeeded in presenting the ground work necessary to a rational approach to this subject.

If faults are to be found in this work, they are those of over simplification in an endeavour to be concise. Thus in the chapter on disinfectants there is some confusion at the outset. There is a very real difference between a bacteriostatic substance and an antiseptic and disinfectant. Bacteriostasis is defined as the inhibition of the growth and development of micro-organisms. Remove the bacteriostatic agent—or neutralise it—and the micro-organisms revive. The fact that there are a large number of chemical compounds used as disinfectants is not necessarily because no suitable substance is useful for all purposes; there just happens to be many quite good disinfecting agents. In discussing the Rideal-

Walker test, the author is in error in stating that *salm. typi* is usually used. This is a standard test and a particular strain of salm. *typhi must* be used under standardised conditions. The influence of various factors on the determination of disinfectants is briefly covered. It should be noted that temperature is important in this respect, disinfecting activity increasing two to four fold for a rise of 10° Centigrade for some substances, whilst for phenol it is much greater. An obvious omission is a reference to the largest class of disinfectants—namely the black and the white coal-tar disinfectants, which are now prepared (by the more reputable makers) from the higher boiling coal tar acids and can be obtained with very high coefficients, yet of relatively low toxicity as compared with the older types in this class.

The bactericidal value of soaps depends largely on the fatty acids used, which have some germicidal action even against *Staphylococcus aureus*. The main function of soap, however, is to remove germs by mechanical means and the author is correct in stating that soap does not sterilise skin. Soap and water is nevertheless a most potent and facile agent for drastically reducing bacterial contamination of skin and materials.

Some aspects of this large field of pharmacology cannot adequately be dealt with, even in a superficial manner, in the space allotted to them in this work. This is certainly the case with insecticides. The author has, however, mentioned the most common compounds used and has stressed their possible toxic effects sufficiently to warn the reader against their indiscriminate use. The paragraph on pyrethrum could have included many more synergists, now used extensively to economise in pyrethrum extract which is in somewhat short supply and is expensive. It might have been emphasised that in no case has insect resistance to the pyrethrins, of any practical significance, yet been encountered. Incidentally the pyrethrins are not resins but esters of chrysanthemum mono and di-carboxylic acids.

One could criticise in somewhat similar detail other parts of the text but the author has set out merely to give an introduction to this very extensive and complicated subject and, in this, it must be conceded he has achieved his object in a commendable manner. This book is intended as a primer for veterinary students but it should also prove useful "refresher" reading to those who have grown older and have forgotten much that they formerly knew (or should have known) about the elementary principles of veterinary pharmacology.

NEWS

MAY & BAKER RESEARCH INSTITUTE

Constructional work on a new Research Institute at Dagenham, Essex, is now nearing completion and these buildings are expected to be equipped and fully operational by early autumn of this year.

The M. & B. Research Institute will comprise three main buildings, a chemical wing; a central building housing the library, lecture theatre and administrative offices, and a biological wing with ancillary buildings. The entire block will provide over 100,000 sq. ft. of floor space.

The new Research Institute will enable existing research units from various laboratories in the Dagenham Works to be brought together in one coherent group. At the same time it will provide additional facilities for M. & B. scientists working on expanded research programmes. Close liaison with the present Agricultural and Veterinary Research Station at Ongar, some twelve miles from the main Dagenham Works, will be continued and further development of this Field Research Station will take place.

GLAXO LABORATORIES LTD.

From Monday, 21st March, a new preparation known as Streptopen Injection will be available to veterinary surgeons. This combined procaine penicillin and dihydrostreptomycin injection contains 250,000 units of procaine penicillin and 0.25 grams dihydrostreptomycin as sulphate per ml. The combined injection is an advantage when treating bacterial infections of mixed origin.

NOTICES

APPOINTMENT OF REGIONAL VETERINARY OFFICERS

Mr. D. Cameron, B.Sc., M.R.C.V.S., D.V.S.M. and Mr. H. M. M. Duff, F.R.C.V.S., D.V.S.M. have been appointed Regional Veterinary Officers of the Ministry of Agriculture, Fisheries and Food.

Mr. Cameron succeeded Mr. John Reid at the Ministry's Animal Health Division headquarters at Tolworth, Surrey on 1st April, 1960 and Mr. Duff will succeed Mr. A. G. Beynon as Regional Veterinary Officer for Wales and Monmouth later in the year. Mr. Duff will be stationed at Aberystwyth.

FOX ENCEPHALITIS : M.F.H. ENQUIRY

The sub-committee set up by the Masters of Foxhounds Association to enquire into the epidemic which has been killing foxes in various parts of East Anglia has asked the Animal Health Trust to become its professional advisors. The disease was identified as Encephalitis at the Trust's Research Station.

The carcases of newly dead foxes should be sent as quickly as possible to the Canine Health Centre, Kennett, near Newmarket, Suffolk, so that efficient examination postmortem may be made.

Publisher's Notices

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